WSDOT MITIGATION SITES
SOUTH CENTRAL REGION

2003 MONITORING REPORT

Wetland Assessment and Monitoring Program

Monitoring Staff
Jesse Barham
Jodie Beall
Fred Bergdolt
Tony Bush
Paul Dreisbach
Cyndie Prehmus
Tuesday Shean
Bob Thomas

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South Central Region 2003 Annual Monitoring Report

For additional information about this report or the WSDOT Wetland Assessment and Monitoring Program, please contact:

Washington State Department of Transportation
Environmental Services Office
P. O. Box 47332
6639 Capital Boulevard South
Tumwater, WA 98504-7732

Fred Bergdolt, Wetland Monitoring Field Coordinator
Phone: 360-570-6645
E-mail: bergdof@wsdot.wa.gov

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Executive Summary

The following tables summarize performance criteria and results obtained in 2003.

Kittitas County Site

Site Name	Performance Criteria	2003 Results
SR 970 Teanaway (Year 4/5)		
	$\geq$ 1.7 stems/m^2 on the site	1.32 stems/m^2 ($CI_{80\%}$ = 1.30-1.34 stems)
	Control of non-native invasive plants	35% aerial cover

Yakima County Sites

Site Name	Performance Criteria	2003 Results
SR 12 Naches River (Year 4/5)		
	50% aerial cover by woody species	35-40% aerial cover
	80% aerial cover in the emergent area, 60% aerial cover of native species	90% aerial cover, 95% of the cover native

SR 823 Selah (Year 3/5)		
	$\geq$ 50% woody cover in forested wetland, at least 3 species	Macroplot 1: 50% ($CI_{90\%}$ = 40-61% cover) Macroplot 2: < 5% aerial cover
		7 woody species observed
	$\leq$ 10% non-native species	Macroplot 1: 2% ($CI_{80\%}$ = 1-2% cover) Macroplot 2: 10% ($CI_{80\%}$ = 8-12% cover)

List of Acronyms

Acronym	Meaning
CI	Confidence Interval (see Methods and Glossary)
ECY	Washington State Department of Ecology
FAC	Facultative Indicator Status (Reed 1988)
FACW	Facultative Wetland Indicator Status (Reed 1988)
IP	Individual Permit
MP	Mile Post
NWP	Nationwide Permit
OBL	Obligate Wetland Indicator Status (Reed 1988)
SR	State Route
USACE	United States Army Corps of Engineers
WDFW	Washington Department of Fish and Wildlife
WSDOF	Washington Department of Fisheries
WSDOT	Washington State Department of Transportation

Introduction

History
Infrastructure improvements including highway construction projects, highway interchanges, and bridges have accompanied economic and population growth in the state of Washington. The Washington State Department of Transportation (WSDOT) routinely evaluates the potential for degradation of critical areas that result from these infrastructure improvements. WSDOT strictly complies with applicable federal, state, and local environmental regulations, including the Clean Water Act and the state "no net loss" policy for wetlands (Executive Order 89-10). Generally, mitigation sites are planned when transportation improvement projects adversely affect critical areas. The WSDOT Wetland Assessment and Monitoring Program monitors these mitigation sites as a means of evaluating compliance with permit conditions and tracking overall development. Sixty-three sites statewide were monitored in 2003. Of the 26 sites included in this year's Annual Monitoring reports, 21 have standards to be addressed in 2003, and five are provided as a requested courtesy.

Purpose
The purpose of this document is to report the status of WSDOT South Central Region mitigation sites with respect to permit compliance and success standards for 2003 (Map 1).[1] We rely on feedback from the users of this report to ensure its contents are clear, concise, and meaningful.

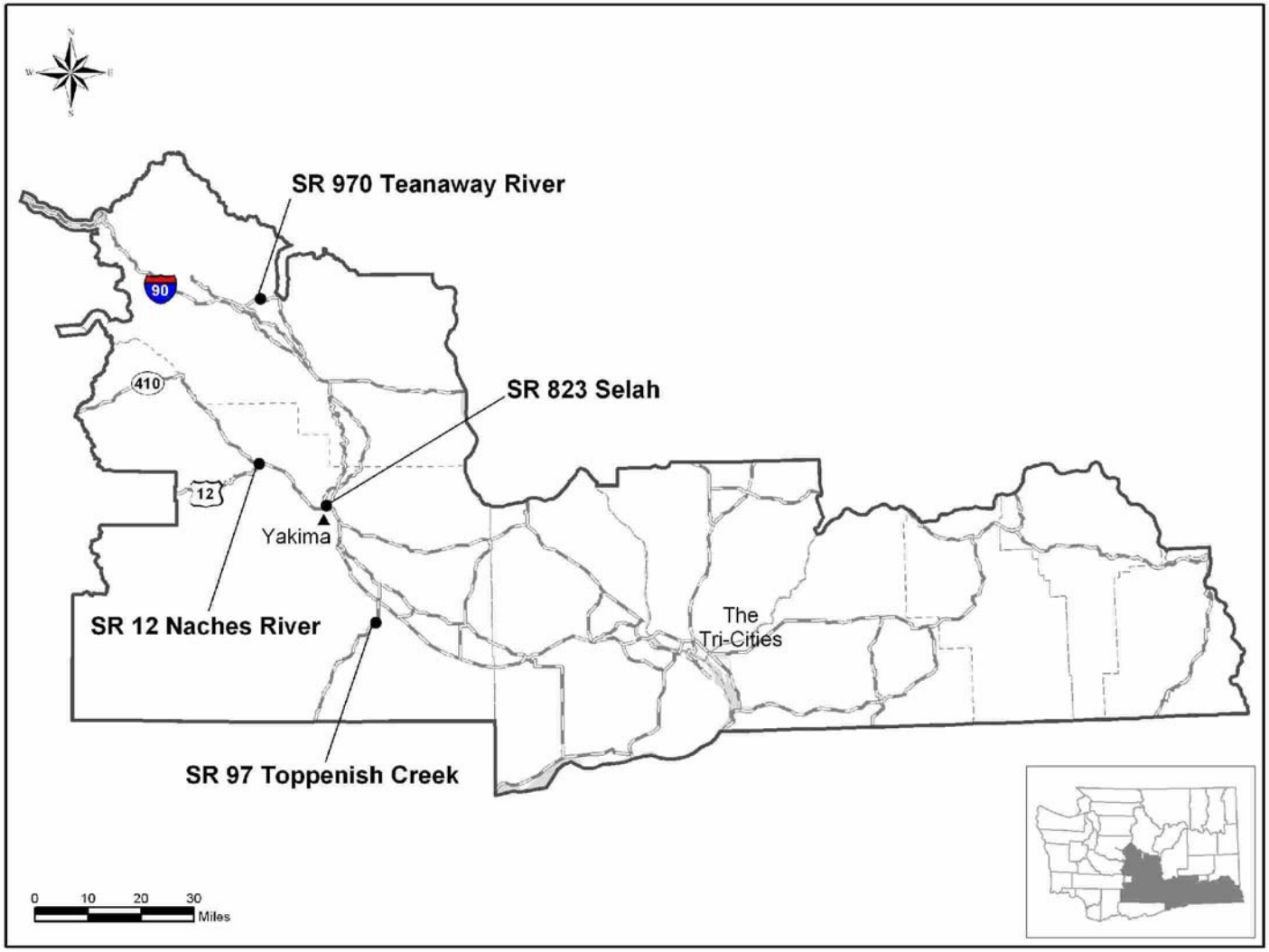
Process
Monitoring typically begins the first spring after a site is planted and continues for the time period designated by the permit or mitigation plan. The monitoring period generally ranges from three to ten years. In special cases sites may be monitored beyond the designated period.

Monitoring activities are driven by site-specific success standards detailed in the mitigation plan or permits. Data are collected on a variety of environmental parameters including vegetation, hydrology, and wildlife. When data analysis is complete, information on site development is communicated to region staff to facilitate management activities as part of an adaptive management process. Monitoring reports are issued to regulatory agencies and published on the web at:

www.wsdot.wa.gov/environment/wetmon/default.htm

[1] Sites shown on the map without reports were evaluated for internal feedback only. A report is issued only for sites with success standards that apply to the current year.

Map 1: South Central Region Sites Monitored in 2003



Methods

Methods used for monitoring mitigation sites change as site requirements and customer needs evolve. Quantitative data collection techniques presently in use are based on standard ecological and biostatistical methods.[2] The wetland program's current monitoring methods include the following key elements:

Objective-based Monitoring

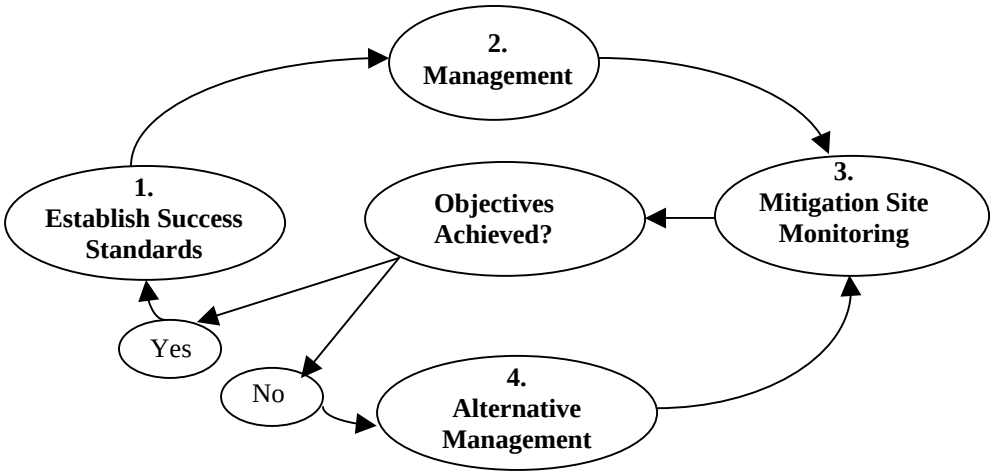
We collect data using a monitoring plan and sampling design developed specifically for each site. The monitoring plan and sampling design address success standards, permit requirements, contingencies, and other considerations as appropriate.

Adaptive Management

The adaptive management process includes four iterative steps:

1. success standards are developed to describe the desired condition,
2. management action is carried out to meet the success standard,
3. the response of the resource is monitored to determine if the success standard has been met, and
4. management is adapted if the standards are not achieved.

Monitoring is integral to the success of an effective adaptive management strategy. Without valid monitoring data, management actions may or may not result in improved conditions or compliance with regulatory permits. Timely decisions, based on valid monitoring data, result in increased efficiency and higher probabilities of success (Shabman 1995; Thom and Wellman 1996). The adaptive management process is illustrated in Figure 1.1.



(Redrawn from Elzinga et al. 1998)

Figure 1.1 The Adaptive Management Process

[2] These methods are based on techniques described in Bonham (1989), Elzinga et al. (1998), Krebs (1999), Zar (1999), and other sources.

Statistical Rigor

WSDOT's monitoring approach strives to minimize subjectivity in data collection and increase the reliability of data collection and analysis. Important considerations include appropriate sampling design, sampling resolution, random sampling procedures, and sample size analysis. Our goal is to provide customers with an objective evaluation of site conditions based on valid and reliable monitoring data.

Success Standards and Sampling Objectives

Site objectives and success standards are important elements of a mitigation plan. They indicate the desired state or condition of the mitigation site at a given point in time. Conditional permit requirements, if different from success standards in the mitigation plan, are also evaluated during monitoring activities. Some mitigation plans also provide contingencies if a specific undesirable condition occurs. Contingencies typically initiate a management response at the onset of a particular condition, for example, excessive cover by invasive species or insufficient cover by trees and shrubs.

Wetland Assessment and Monitoring Program staff thoroughly examine goals, objectives, success standards, and site permits to understand the desired site condition or characteristics to be measured. Six elements are sought in relation to each success standard to ensure measurability of the desired condition: species indicator, location, attribute, action, quantity/status, and time frame. Where one or more of the six elements is undocumented or unclear in the mitigation plan or permit, clarification is sought from region staff.

Success Standards are copied verbatim from the mitigation plan in the Success Standards and Sampling Objectives section of each site report. Differences in common usage of the terms *aerial* and *areal* have made their interpretation in mitigation plans difficult. We feel that the term *aerial* better describes the intent of the mitigation plans in most cases. Where we judge the word *areal* has been used arbitrarily in the Success Standards, we follow it with a (*sic*) notation. The Glossary defines the meaning of these words as used in this document.

Information presented in the first table of each site report is obtained directly from the mitigation plan and permits, as appropriate.

Sampling may be required to address success standards unless an efficient and reliable total accounting of the target attribute can be conducted. Sampling objectives are developed to guide the data collection process. Sampling objectives typically include a confidence level and confidence interval half width.

The results of sampling are included in the individual site reports with the confidence level and confidence interval noted as ($CI_X = Y_1$-Y_2), where CI = confidence interval, X = confidence level, and confidence interval width is expressed as Y_1 low estimate to Y_2 high estimate. For example, an estimated aerial cover provided by woody species reported as 65% ($CI_{80\%}$ = 52-78% aerial cover) means that we are 80% confident that the true aerial cover value is between 52% and 78% (Figure 1.2).

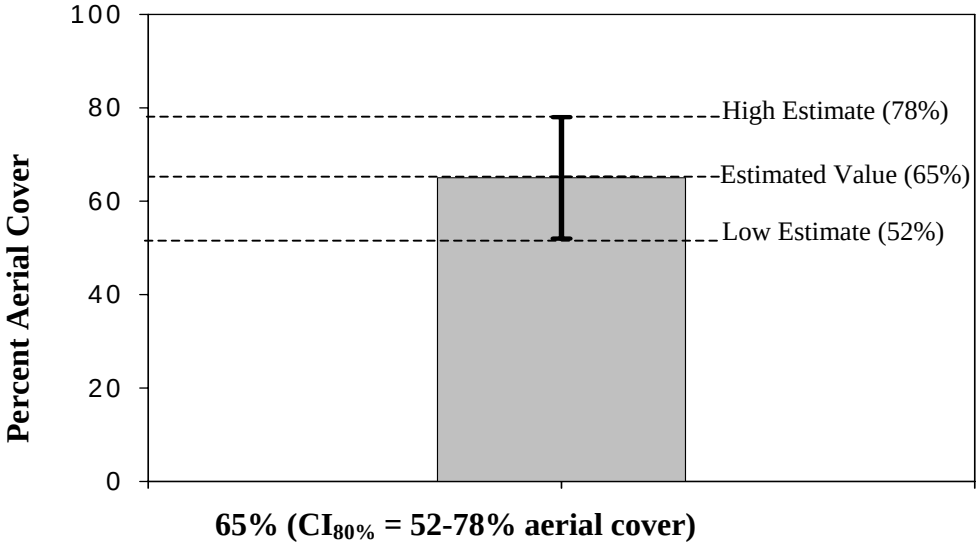


Figure 1.2 Estimated Cover Value Expressed with Confidence Interval Range

For compliance purposes, aerial cover calculations include only areas covered by rooted vascular plants (including floating-leaved species). Areas covered by thallophytes (algae, fungi, bacteria), bryophytes (mosses and liverworts), structures, or aquatic vegetation are not included in aerial cover calculations. Scientific names, most common names, and nativity used in this report were obtained from the *PLANTS Database* (USDA 2003). Hydrophytic plant indicator status was obtained from the *National List of Plant Species that Occur in Wetlands: Northwest* (Reed 1988 and 1993). Where invasive or noxious weeds are addressed, county specific listings from the *State Noxious Weed List* are referenced (Washington State Noxious Weed Control Board 2003).[3]

Sampling Design

When sampling is required, a sampling design is developed for the site or zone of interest. Sampling designs can vary from simple to complex depending on the number and type of attributes to be measured. Specific elements such as the size and shape of the site, the presence of environmental gradients, plant distribution patterns, and the amount of time and resources available for monitoring are factors that influence the sampling design. Elements of the sampling design may include the location of the baseline, orientation of transects (Figure 1.3), the method of data collection, and the number and type of sample units to be used. Depending on the sampling objective and site characteristics, transects may vary in number, length, and separation distance. Sampling transect locations are determined by using either a simple, systematic, stratified, or restricted random sampling method.

[3] In some cases, other nuisance species may be included in invasive cover estimates.

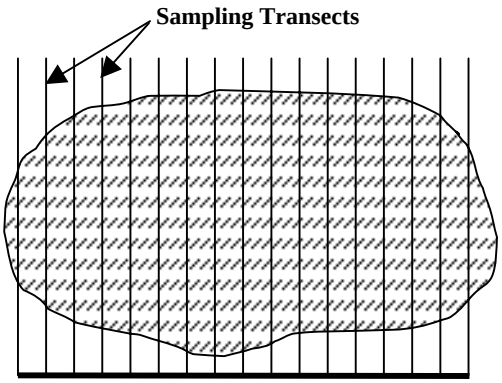


Figure 1.3 Baseline and Sampling Transects

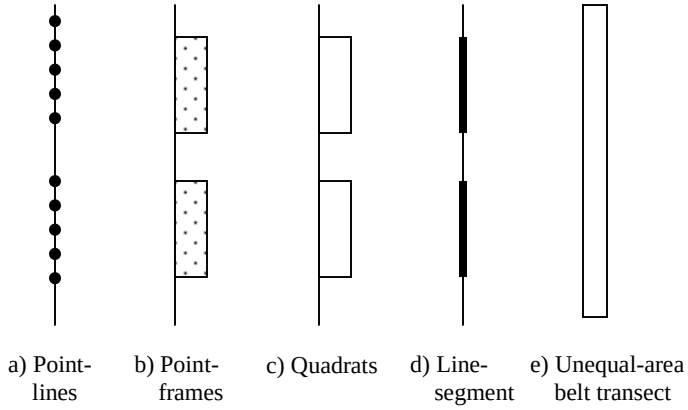


Figure 1.4 (a-e) Sampling Transects and Sample Units

A diagram showing the sampling design is typically included in mitigation site reports. Sample units appropriate to one or more of the methods described below are randomly located on or adjacent to the sampling transects (Figure 1.4 a-e). These drawings are general representations of the actual sampling designs and do not include specific details.

Point-Line Method

The point-line technique (Bonham 1989; Elzinga et al. 1998) can be used where vegetative cover is an attribute of interest. This method involves randomly locating sample units consisting of fixed sets of points along sampling transects (Figure 1.4a). Tools used to collect point-line data include point-intercept devices, pin flags, or densitometers. These tools are used to identify point locations. Target vegetation intercepted by the point locator is recorded. If target species are not encountered on the point; bare soil, non-vascular plant, or habitat structure is recorded as appropriate. For each sample unit, cover is determined based on the number of times target vegetation is encountered divided by the total number of points. For example, if invasive species were encountered on 20 points from a sample unit composed of 100 points, the aerial cover of invasive species for that sample unit is 20 percent.

Point-Frame Method

Point-frames are another tool that may be used to measure vegetative cover (Bonham 1989; Elzinga et al. 1998). A point-frame is a rectangular frame that encloses a set of points collectively serving as a sample unit (Figure 1.4b).[4] The sample unit is lowered over herbaceous vegetation and data is recorded where target vegetation intercepts point locations. As with the point-line method, a cover value for each sample unit is determined. For example, if FACW and OBL species were encountered on 20 points in a point-frame composed of 40 points, the aerial cover of FACW and OBL species for that point-frame sample unit is 50 percent.

[4] The WSDOT Wetland Assessment and Monitoring Program typically uses a frame formed with polyvinyl chloride (PVC). Strings span the frame lengthwise and points are marked on the strings using a standard randomization method.

Quadrat Method

To measure survival or density of planted trees and shrubs in an area, quadrat sample units are randomly located along sampling transects (Bonham 1989; Elzinga et al. 1998). Quadrat width and length are based on characteristics of the vegetative community and patterns of plant distribution. Quadrats are typically located lengthwise along sampling transects (Figure 1.4c). Plants within a quadrat are recorded as alive, stressed or dead. The success standard or contingency threshold can be addressed with a percent survival estimate of plantings, or a density per square meter of living plantings as appropriate. For example, if eight planted woody species were recorded as alive and two were recorded as dead in a sample unit measuring 1 x 20 meters, the survival of planted woody species for that sample unit would be 80%, and the density would be 0.4 live plants per square meter.

Line-Intercept Method

Cover data for the woody species community is collected using the line-intercept method (Bonham 1989; Elzinga et al.1998).[5] Line-segments, serving as sample units, are randomly located along sampling transects (Figure 1.4d). All woody vegetation intercepting the length of each sample unit is identified and the length of each canopy intercept recorded. For each sample unit, the sum of the canopy intercept lengths is divided by the total length to calculate an aerial cover value. For example, if woody vegetation was encountered on 80 meters from a 100-meter sample unit, the aerial cover for that sample unit is 80 percent.

Sample Size Analysis

With each of the above methods, sample size analysis is performed in the field to ensure that an adequate number of sample units are obtained to report the data at the specified confidence level and interval. The mean percent aerial cover value and standard deviation are calculated from the data, and sample size analysis is conducted. For data reported in this document, the following sample size equation for estimating a single population mean or a population total within a specified level of precision was used to perform this analysis (Elzinga et al. 1998).

$$n = \frac{(z)^2 (s)^2}{(B)^2}$$

z = standard normal deviate
s = sample standard deviation
B = precision level[6]
n = unadjusted sample size

A sample size correction to n is necessary for adjusting "point-in-time" parameter estimates.[7] It is the adjusted n value that reveals the number of sample units required to report the estimated mean value at a specified level of confidence.

[5] Depending on site conditions and other considerations, woody cover data may be collected using the point-line method and a densitometer.

[6] In this equation, the precision level equals half the maximum acceptable confidence interval width multiplied by the sample mean.

[7] Adjusted n values found in this report were obtained using the algorithm for a one-sample tolerance probability of 0.90 (Kupper and Hafner 1989; Elzinga et al 1998).

Unequal-Area Belt Transect Method

For surveys of irregularly shaped regions, the unequal-area belt transect method provides an easy-to-implement sampling protocol that may be particularly useful for assessments of woody species density or survival (Stehman and Salzer 2000). With this technique, fixed-width belt transects (quadrats) are positioned perpendicular to a baseline using a simple, systematic, or restricted random sampling method. Once a belt transect has been located, field crews traverse the entire length of the transect counting all plants within the perimeter of the belt transect.

The following equations are used to analyze plant density data collected from unequal-area belt transects.

First, density is estimated using a ratio estimator of the mean number of plants per transect divided by the mean area per transect.

$$\hat{D} = \frac{\bar{y}}{\bar{a}}$$

$\hat{D}$ = sample-based estimator of density
$\bar{y}$ = sample mean plants per transect
$\bar{a}$ = sample mean transect area

Second, variance of the sample-based density estimator is derived from the following equation.

$$\hat{V}(\hat{D}) = \frac{1}{\bar{a}^2}\left(\frac{N-n}{N}\right)\frac{s_e^2}{n}$$

N = population size
n = sample size
s_e^2 = pooled variance[8]
$\hat{V}(\hat{D})$ = variance of the density

Finally, a confidence interval for the sample-based estimator is calculated as follows.

$$\hat{D} \pm (t)[SE(\hat{D})]$$

$\hat{D}$ = sample-based estimator of density
SE = sample standard error

For more information on the unequal-area belt transect method and data analysis techniques see Stehman and Salzer (2000).

Hydrology Monitoring

Primary and secondary field indicators of wetland hydrology (ECY 1997) are recorded to address hydrology standards and to aid in future delineation efforts. Wetland mitigation sites are delineated in the spring following the last year of vegetation monitoring so the actual wetland area can be compared to the planned wetland area.

[8] $s_e^2 = \sum_s \left(y_u - \hat{D}a_u\right)^2 \Big/ (n-1)$

Kittitas County Site

SR 970 Teanaway

The following report summarizes monitoring activities completed by the Washington State Department of Transportation (WSDOT) Wetland Assessment and Monitoring Program at the SR 970 Teanaway River restoration site in July 2003. Vegetation data were obtained to compare to third and fourth-year permit requirements.[9] Table 2.1 provides general site information and Table 2.2 summarizes this year's monitoring results.

Table 2.1 General Information for the SR 970 Teanaway River Mitigation Site

Project Name	SR 970 Teanaway River Bridge
USACE Sect. 401 WQ Cert. No.	97-4-01124
Mitigation Location	NW corner of SR 970/Teanaway River, Cle Elum, Kittitas County
Township/Range/Section (impact)	T.20N/R.15E/S.25
Monitoring Period	2000 to 2004
Year of Monitoring	4 of 5
Area of Project Impact	12.12 acres
Type of Mitigation	Re-Channelization/Restoration

Table 2.2 Monitoring Summary for the SR 970 Teanaway Mitigation Site

Performance Criteria	2003 Results[10]	Management Activities
Permit Requirement 1 (Special Condition h)		
1. $\geq$ 1.70 stems/m^2 on the site	1.32 stems/m^2 ($CI_{80\%}$ = 1.30-1.34 stems)	Irrigation
Permit Requirement 2 (Special Condition h)		
2. Control of non-native invasive plants	35% aerial cover	Weed control

Permit Requirements

Permit requirements for the SR 970 Teanaway River restoration site were excerpted from the *United States Army Corps of Engineers Individual Permit 97-4-01124* (USACE 1997). A companion sampling objective follows Permit Requirement 1 (Special Condition h). Appendix A provides a complete text of the monitoring-related permit requirements for this project.

[9] The third-year target for the woody species plant community (1.7 stems/m^2) was not achieved in 2002. Plant density was quantitatively re-evaluated in July 2003.

[10] Estimated values are presented with their corresponding statistical confidence interval. For example, 1.32 stems/m^2 ($CI_{80\%}$ = 1.30-1.34 stems) means we are 80% confident that the density value is between 1.31 and 1.34 stems/m^2.

Permit Requirement 1 (Special Condition h)
An 80% [planted woody species] survival rate shall occur at the end of the third-year monitoring period (2002).

Note: 80% survival is interpreted as a density of 1.7 stems per square meter on the site. This allows both volunteer and planted woody species to be included (James Morin personal communication, April 2001).

> Sampling Objective 1
> To be 80% confident the true woody species stem density is within 20% of the estimated density in 2003.

Permit Requirement 2 (Special Condition h)
Control of non-native invasive plants during the 5-year vegetation-monitoring period (2000-2004).

Methods

Sampling was conducted to estimate woody species stem density in both the riparian re-vegetation and stream channel relocation zones of the SR 970 Teanaway River restoration site. For both zones, an unequal-area belt transect method was implemented to survey the target plant community. The following describes sampling strategies and methods implemented at the restoration site this year.

Stream Channel Relocation Zone
The sampling area in the stream channel relocation zone was divided into two strata (stratified random sampling) based on moisture gradient and differences observed in the target plant population (Figure 2.1). A systematic random sampling method was used to position 41 fixed-width (one meter wide) belt transects perpendicular to a 153-meter baseline along the east bank of the secondary stream channel. Twenty-one belt transects were located in Stratum 1 and 20 belt transects were located in Stratum 2. Field crews identified and counted all woody plants (planted and volunteer) within the boundaries of each belt transect. Transects were variable in length due to the irregular boundaries of the sampling area.

Riparian Re-vegetation Zone
Similar methods were employed along the riparian corridor (Figure 2.1). Fifty-five unequal-area, fixed-width (one meter wide) belt transects were positioned along a 216-meter baseline located parallel to the river channel. Trees and shrubs were identified and counted within the boundaries of each belt transect.

A qualitative assessment of invasive plant species cover was conducted for each of the re-vegetation zones.

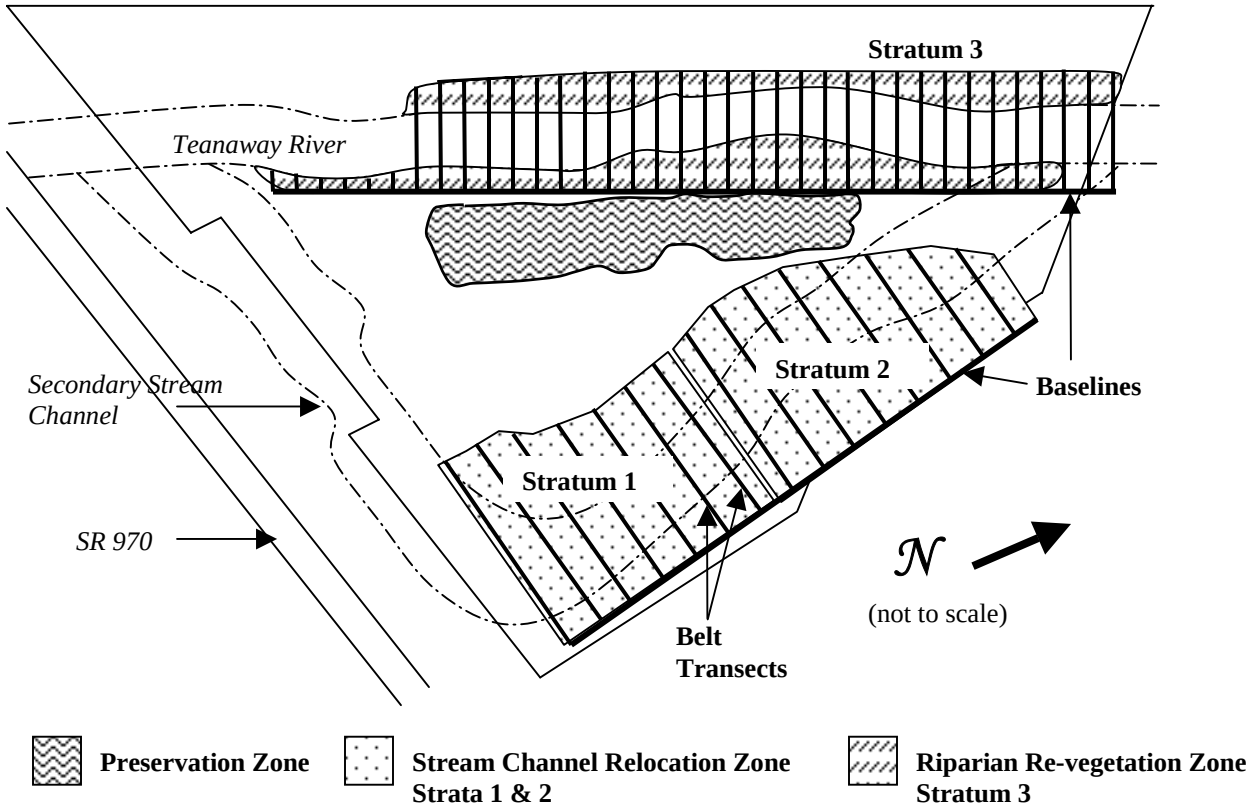


Figure 2.1 SR 970 Teanaway Restoration Site Sampling Design (2003)

For additional details regarding methods, see the Methods section of this report.

Results and Discussion

Permit Requirement 1 – At Least 1.7 Stems/m^2

The stem density for woody species in the riparian re-vegetation and stream channel relocation zones (Strata 1-3) is estimated to be 1.32 stems/m^2 ($CI_{80\%}$ = 1.30-1.34 stems/ m^2). Though this value does not meet the target (1.7 stems/m^2) specified in the permit, many of the original plantings have survived and colonization has been observed in most areas of the restoration site. Replanting woody species may not be necessary if colonization continues.

In the stream channel relocation zone, woody species density ranges from 0.31 stems/m^2 ($CI_{80\%}$ = 0.28-0.34 stems/ m^2) in the south (Stratum 1) to 2.48 stems/m^2 ($CI_{80\%}$ = 2.13-2.84) in the north (Stratum 2) (Figure 2.1). Planted and volunteer woody species seem to be well established in sampling Stratum 2. Colonization of *Populus balsamifera* (black cottonwood) and *Salix* species (willows) continues in this area, and qualitative estimates of tree and shrub cover appear unchanged from 2002 to 2003.

Stem density for woody species along the riparian corridor (Stratum 3) is estimated to be 1.15 stems/m^2 ($CI_{80\%}$ = 0.97-1.32 stems/ m^2). Woody species plant establishment has been difficult due to natural alterations of the riverbank during periods of high runoff and peak water flow. However, volunteer *P. balsamifera* and *Salix* species have colonized a few areas along the east bank of the Teanaway River (Figure 2.2). If major alterations to the river channel do not occur in the next couple of years, natural recruitment should increase woody species stem density along the riparian corridor.

Figure 2.2 SR 970 Teanaway Mitigation Site (July 2003)

Permit Requirement 2 – Control of Non-Native Invasive Plants

The aerial cover of non-native invasive species across the restoration site was qualitatively estimated to be 35 percent. This value is higher than last year's qualitative estimate of less than 10 percent. *Bromus tectorum* (cheatgrass), *Centaurea diffusa* (diffuse knapweed), and *Phalaris arundinacea* (reed canarygrass) have increased in cover since 2002. Weed control activities have been effective in the past and are recommended for continued control of these invasive species.

The following additional invasive species are present at low cover levels. These species do not appear to pose an immediate threat to site development.

- *Cardaria chalapensis* (lensepod whitecress)
- *Centaurea debeauxii* (meadow knapweed)
- *Cirsium arvense* (Canada thistle)
- *Cirsium vulgare* (bull thistle)
- *Hypericum perforatum* (common St. Johnswort)
- *Kochia scoparia* (Mexican fireweed)
- *Leucanthemum vulgare* (oxeye daisy)
- *Melilotus alba* (white sweetclover)
- *Verbascum thapsus* (common mullein)

Management Activities

Woody species replanting has taken place each of the past 3 years. In 2003, 200 plants were installed west of the Teanaway River. Irrigation and weed control efforts are ongoing.

Yakima County Sites

SR 12 Naches River

The following report summarizes monitoring activities completed by the WSDOT Wetland Assessment and Monitoring Program at the SR 12 Naches River mitigation site in July 2003. Monitoring data were obtained to compare to fifth-year success standards (2004). Activities included vegetation surveys of planted areas. Table 3.1 provides general site information and Table 3.2 summarizes this year's monitoring results.

Table 3.1 General Information for the SR 12 Naches River Mitigation Site

Project Name	SR 12 Naches River	
USACE IP Number	94-4-00800	
Mitigation Location	SR 12 Bridge at the Naches River, Yakima County	
Township/Range/Section (impact)	T.15/R.16E/S.35	
Monitoring Period	2000 to 2004	
Year of Monitoring	4 of 5	
Area of Project Impact	2.09 acres	
Type of Mitigation	Wetland Creation	Wetland Preservation
Area of Mitigation	0.22 acres	0.34 acres
Type of Mitigation	Buffer Creation	Buffer Enhancement
Area of Mitigation	0.40 acres	0.15 acres

Table 3.2 Monitoring Summary for the SR 12 Naches River Mitigation Site

Standards of Success (2004)	2003 Results	Management Activities
1. 50% aerial cover by woody species	35-40% aerial cover	
2. 80% aerial cover in the emergent area, 60% aerial cover of native species	90% aerial cover, 95% of the cover native	Weed control

Success Standards

The fourth-year success standards for the SR 12 Naches River mitigation site were excerpted from the *Final Wetland Mitigation plan for SR 12 Naches River Bridge Replacement 12/320* (Smith and Russell 1996). Appendix B provides the complete text of the success standards for this project.

Success Standard 1
50% aerial cover of woody species in the scrub-shrub and forested zones of the site (2004).

Success Standard 2
At least 80% aerial cover of vegetation in the emergent zone, of which 60% of the species are native (2004).

Methods

Qualitative estimates were made to assess the aerial cover of woody species in the scrub-shrub and forested zones (Success Standard 1), and the aerial cover and nativity of plants in the emergent zone (Success Standard 2). A sketch of the site is shown in Figure 3.1.

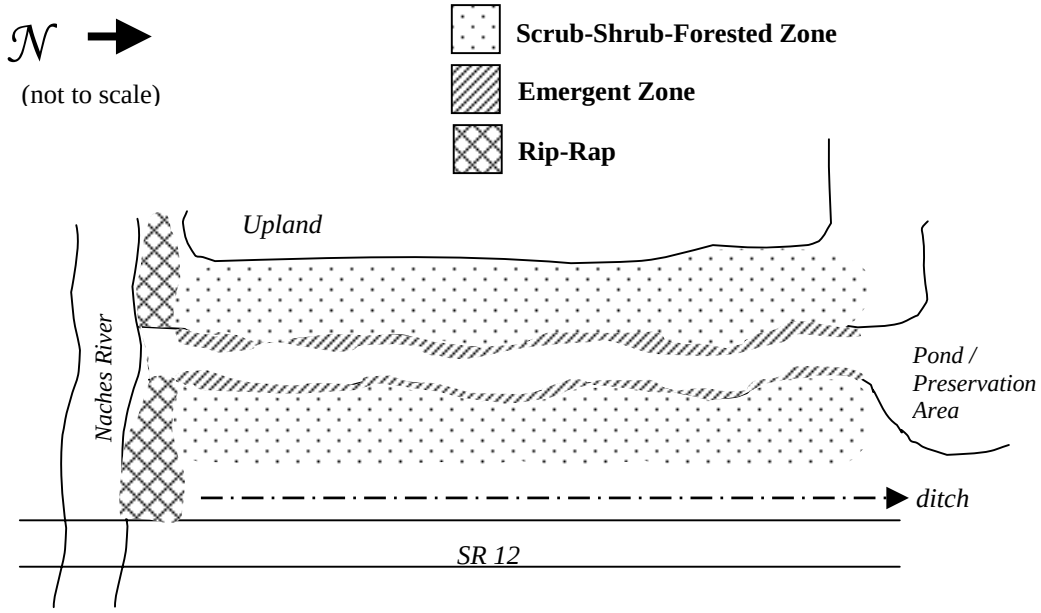


Figure 3.1 SR 12 Naches River Mitigation Site Sketch (2003)

Results and Discussion

Success Standard 1 – 50% Woody Cover in the Scrub-Shrub and Emergent Zones
A qualitative assessment for aerial cover of woody species in the scrub-shrub and emergent zones was 35-40% this year (2003). This estimate approaches the 50% cover requirement for 2004. Table 3.3 provides a list of woody species found on the site.

Table 3.3 Woody Species Observed at the SR 12 Naches River Mitigation Site (2003)

Scientific Name	Common Name
Alnus rubra	red alder
Artemisia tridentata	big sagebrush
Cornus sericea	redosier dogwood
Populus balsamifera	black cottonwood
Purshia tridentata	antelope bitterbrush
Ribes aureum	golden currant
Robinia pseudoacacia	black locust
Rosa woodsii	Wood's rose
Salix exigua	sandbar willow
Salix lucida	Pacific willow
Symphoricarpos albus	snowberry

Success Standard 2 – 80% Aerial Cover in the Emergent Zone, 60% Native Species
A qualitative assessment of aerial cover in the emergent zone was 90 percent. Native species were estimated to provide 95% of this cover. This appears to be an increase in cover since the 2002 quantitative estimate (69% aerial cover with 62% native cover). If this year's qualitative estimates reflect a true cover increase in the emergent zone, Success Standard 2 will likely be achieved in 2004.

Additional Information

Invasive species aerial cover was qualitatively estimated to be two to three percent. Invasive species observed include *Centaurea biebersteinii* (spotted knapweed), *Centaurea diffusa* (diffuse knapweed), *Cirsium arvense* (Canada thistle), *Phalaris arundinacea* (reed canarygrass), and *Rubus armeniacus* (Himalayan blackberry). Weed control measures appear to have been effective at maintaining low levels of invasive species.

Management Activities

Ongoing weed control has targeted noxious and undesirable plant species with an emphasis on *C. arvense*, *Verbascum thapsus* (common mullein), and *Salsola tragus* (prickly Russian thistle). Weed control has been conducted both on site and in the surrounding area.

SR 823 Selah, Yakima County

The following report summarizes monitoring activities completed by the WSDOT Wetland Monitoring Program at the SR 823 Selah mitigation site in July 2003. Monitoring data were obtained to evaluate third-year progress toward fifth-year success standards. Activities include surveys of the planted wetland and buffer plant communities. Table 4.1 provides general site information and Table 4.2 summarizes this year's monitoring results.

Table 4.1 General Information for the SR 823 Selah Mitigation Site

Project Name	SR 823, I-82 to Selah Interconnect	
USACE IP Number	97-4-01405	
Mitigation Location	Harlan Landing at the Yakima River, Yakima County	
Township/Range/Section (impact)	T.13N/R.18E/S.12, SW/4, NW/4	
Monitoring Period	2001 to 2005	
Year of Monitoring	3 of 5	
Area of Project Impact	0.88 acres	
Type of Mitigation	Wetland Creation/ Enhancement	Buffer Creation/ Enhancement
Area of Mitigation	3.20 acres	0.80 acres

Table 4.2 Monitoring Summary for the SR 823 Selah Mitigation Site

Success Standards (2005)	2003 Results[11]	Management Activities
1. $\geq$ 50% woody cover in forested wetland, at least 3 species	Macroplot 1: 50% ($CI_{90\%}$ = 40-61% cover) Macroplot 2: < 5% aerial cover	Irrigation and replanting
	7 woody species observed	Replanting
2. $\leq$ 10% non-native species	Macroplot 1: 2% ($CI_{80\%}$ = 1-2% cover) Macroplot 2: 10% ($CI_{80\%}$ = 8-12% cover)	Weed control

Success Standards and Sampling Objectives

Fifth-year success standards for the SR 823 Selah mitigation site were excerpted from the *SR 82 Selah – Yakima Interconnect Final Wetland Mitigation Plan* (Watson and Russell 1995). Sampling objectives follow success standards where appropriate. Appendix C provides the complete text of the success standards for this project.

[11] Estimated values are presented with their corresponding statistical confidence interval. For example, 50% ($CI_{90\%}$ = 40-61% cover) means we are 90% confident that the true aerial cover value is between 40% and 61percent.

Success Standard 1
The site will have attained greater than or equal to 50% cover by at least 3 woody species in the forested and scrub-shrub zones of the wetland (2005).

Sampling Objective 1
To be 80% confident that the true aerial cover of woody species in the wetland contained in macroplot 1 is within 20% of the aerial cover estimate.

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Success Standard 2
Cover of non-native species will not exceed 10% (2005).

Sampling Objective 2
To be 80% confident that the true aerial cover of undesirable species is within 20% of the aerial cover estimate.

Methods

The site is divided into two sections by a preservation area. These two areas have exhibited differing initial survival and subsequent management. In order to prevent impacts to the preservation area, the two areas were sampled separately by placing a macroplot on each side of the preservation area. See Figure 4.1 for a diagram of the sampling design.

Macroplot 1
The baseline for Macroplot 1 was placed on the southwest edge of the site running parallel to the Yakima River. Twenty-five temporary transects were placed perpendicular to the baseline using a systematic random sampling method. Transects terminated at the edge of the preservation area. Twenty line-segment sample units, 15 meters in length, were randomly placed along sampling transects to estimate aerial cover of woody plants in the wetland area (Success Standard 1). Twenty-five point-line sample units, 50 meters in length (200 points each), were randomly placed along sampling transects to estimate aerial cover of undesirable species (Success Standard 2).

Macroplot 2
The baseline for Macroplot 2 was placed parallel to the fence-line adjacent to the highway. Thirty transects were placed perpendicular to the baseline using a systematic random sampling method. Due to low cover of woody vegetation in this area sampling was conducted only to address the undesirable species cover threshold. Thirty point-line sample units, 30 meters in length (120 points each), were randomly placed along sampling transects (Success Standard 2).

Qualitative data were collected on aerial cover of woody species in the wetland area of Macroplot 2 (Success Standard 1).

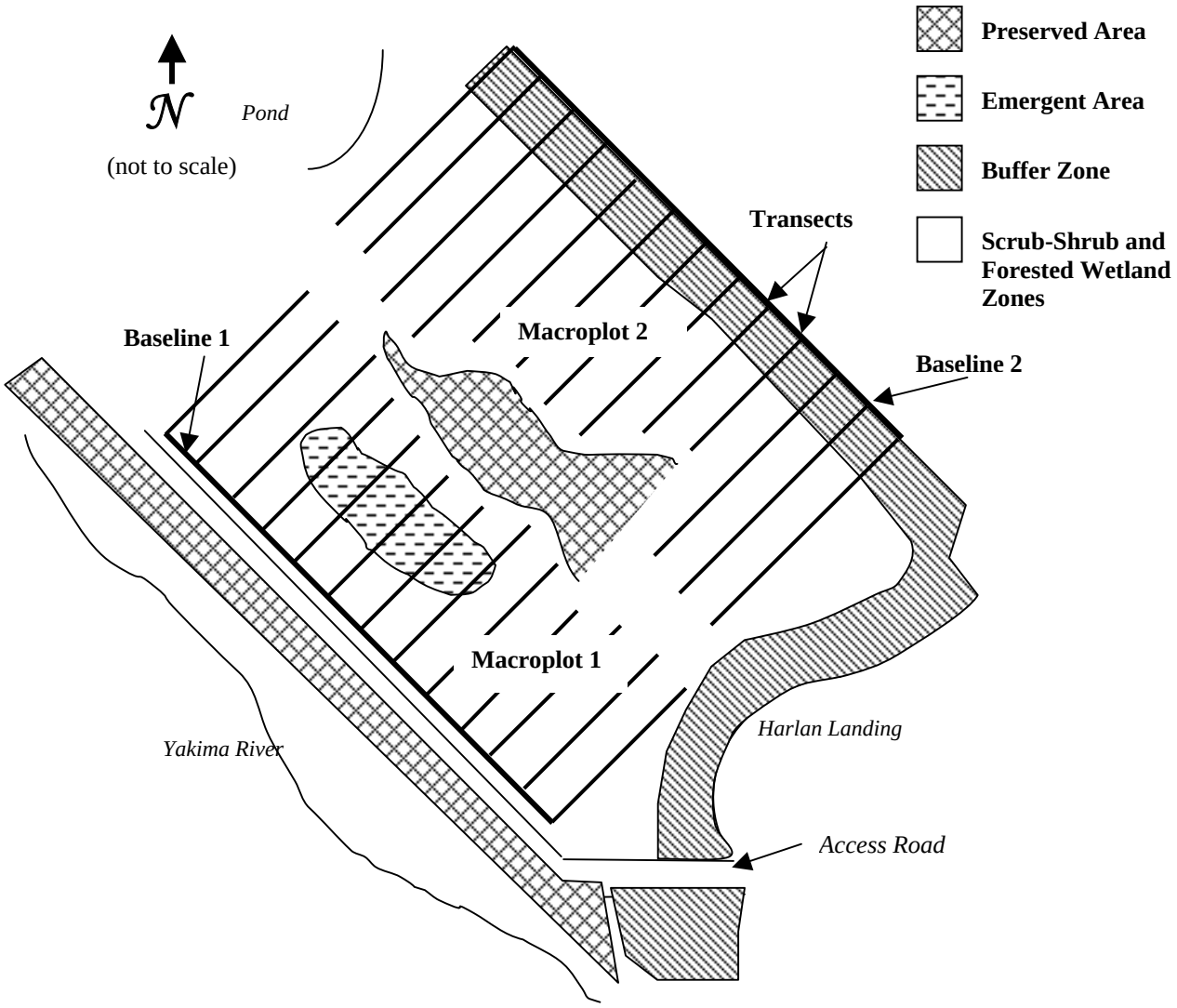

Figure 4.1 SR 823 Selah Mitigation Site Sampling Design (2003)

Sample size analysis was conducted using the following equation.

$$n = \frac{(z)^2 (s)^2}{(B)^2}$$

z = standard normal deviate
s = sample standard deviation
B = precision level[12]
n = unadjusted sample size

For additional details on the methods described above, see the Methods section of this report.

[12] The precision level equals half the maximum acceptable confidence interval width multiplied by the sample mean.

Results and Discussion

Success Standard 1 – > 50% Woody Cover in Forested/Scrub-Shrub Zones, Comprised of at Least 3 Woody Species

Woody species aerial cover in the wetland portion of Macroplot 1 is estimated to be 50% ($CI_{90\%}$ = 40-61% cover). In Macroplot 2, a qualitative estimate indicates that the cover of woody species was less than five percent. When considered together, these estimates suggest that overall woody cover in the forested and scrub-shrub zones is considerably lower than the 50% intended for 2005. More than three woody species were observed in the wetland portion of both macroplots satisfying the diversity requirement in the success standard (Table 4.3).

The differences in woody aerial cover and plant establishment between the two portions of the site may be due to a number of factors. Planted materials in Macroplot 1 have benefited from favorable soil and hydrologic conditions. The area where Marcoplot 2 was positioned, initially suffered from marginal soil and hydrologic conditions before mid-course management activities occurred. Remediation plans (re-grading, replanting, and irrigation) were initiated to correct plant establishment issues in 2002. New plantings are presently established and continued irrigation and improved environmental conditions should bring the site closer to fifth-year aerial cover requirements by 2005.

Table 4.3 Woody Species Observed at the SR 823 Selah Mitigation Site in 2003

Scientific Name	Common Name
Wetland	
Betula occidentalis	water birch
Cornus sericea	redosier dogwood
Crataegus douglasii	black hawthorn
Populus balsamifera	black cottonwood
Populus tremuloides	quaking aspen
Salix lucida	Pacific willow
Salix exigua	sandbar willow
Upland	
Populus balsamifera	black cottonwood
Ribes aureum	golden currant
Rosa woodsii	Wood's rose
Sambucus nigra	blue elderberry
Symphoricarpos albus	snowberry

Success Standard 2 – < 10% Cover by Non-Native Species

Data were collected on invasive species as a substitute for non-native species (Table 4.4). The aerial cover estimate of invasive species in Macroplot 1 was 2% ($CI_{80\%}$ = 1-2% cover) and in Macroplot 2 was 10% ($CI_{80\%}$ = 8-12% cover). Most plants observed were stressed due to herbicide application prior to the monitoring visit. These were recorded as alive in the sampling conducted. Thus, much of the aerial cover by invasive species may have been short lived if herbicide application was effective. In general, control of

invasive species has been effective, and continued control should further reduce the presence of these species.

Table 4.4 Invasive Species Observed at the SR 823 Selah Mitigation Site in 2003

Scientific Name	Common Name
Amaranthus retroflexus	redroot pigweed
Cirsium arvense	Canada thistle
Kochia scoparia	Mexican fireweed
Lepidium latifolium	broadleaved pepperweed
Lythrum salicaria	purple loosestrife
Phalaris arundinacea	reed canarygrass
Salsola tragus	prickly Russian thistle
Sisymbrium altissimum	tall tumble mustard
Solanum dulcamara	climbing nightshade
Tanacetum vulgare	common tansy

Additional Information

Survival data was collected in both macroplots to gauge the effectiveness of replanting in late 2002. Survival in Macroplot 1 was estimated to be 94% ($CI_{90\%}$ = 90-99% survival) and in Macroplot 2 was estimated to be 93% ($CI_{90\%}$ = 89-97% survival) (Figure 4.2). Data suggests that the irrigation provided in 2003 has been beneficial for woody species establishment.

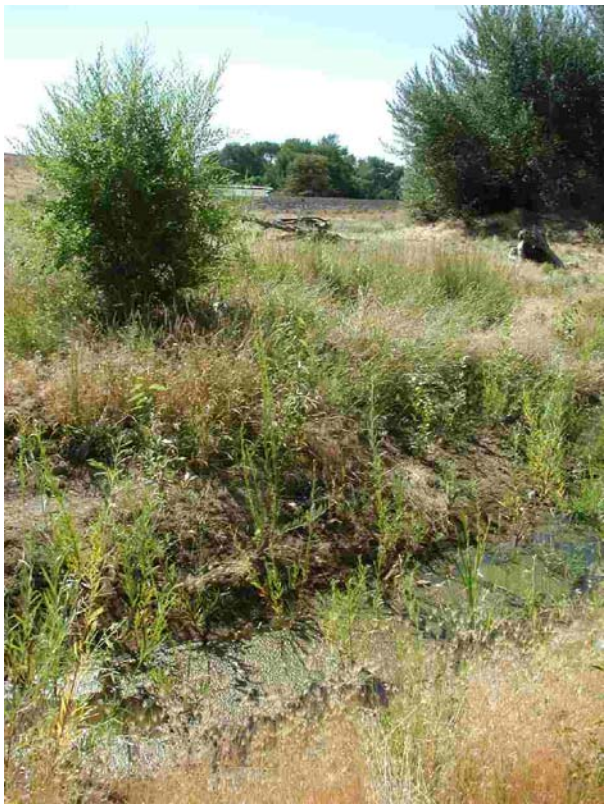

Figure 4.2 SR 823 Selah Macroplot 2 (July 2003)

Management Activities

Irrigation has been provided from a shallow well on site during the summer of 2003. Weekly weed control targeted noxious and invasive plant species during the summer of 2003. Replanting of woody species occurred in the 2002-03 planting season and additional planting is planned for March 2004. Marginal soil was removed and a new sinuous channel constructed on the dry side of the site (Figure 4.2) in Fall 2002.

Appendices

Appendix A

SR 970 Teanaway Success Standards

The following excerpt is from the *United States Army Corps of Engineers Individual Permit 97-4-01124* (USACE 1997). The criteria addressed this year are identified in **bold** font.

Permit Requirements:

Special Condition e: A contingency plan shall be developed by WSDOT which will detail the following: actions to be taken in the event of adverse weather conditions during construction, a plan for the control of non-native invasive plants during the 5-year vegetation monitoring period, and a plan for replanting plants which do not meet the survival criteria specified in condition (h).

Special Condition h: Invasive plant control shall occur as specified in the contingency plan described in condition (e). An 80% survival rate shall occur at the end of the first, second, and third-year monitoring periods. If 80% survival is not obtained, plants shall be replanted in the next planting season following the monitoring period where lack of survival was determined.

Note: 80% survival is interpreted as a density of 1.7 stems per square meter on the site. This allows both volunteer and planted woody species to be included. (James Morin personal communication, April 2001).

Appendix B

SR 12 Naches Success Standards

The following success standards are excerpted from the *Final Wetland Mitigation Plan for SR 12 Naches River Bridge Replacement 12/320* (Smith and Russell 1996). The standards addressed this year are identified in **bold** font.

Mitigation Goals

The goals of the mitigation project replace the lost functions and values of the impacted wetlands, and provide a combination of diverse out-of-kind enhancements. WSDOT proposes to create 0.09 hectares (0.40 acres) of buffer, preserve 0.06 hectares (0.15 acres) of buffer, and preserve 0.14 hectares (0.34 acres) of existing wetland. It is intended that wetland and buffer creation and preservation will produce an ecologically diverse system, providing wildlife habitat and food chain support, surface water discharge, flood runoff attenuation in very large flood events, sediment/toxicant retention, and nutrient removal and transformation. These functions will enhance the riparian ecosystem of the Naches River corridor.

Objectives and Standards of Success

Objective: Create a wetland and riparian corridor community vegetated with a diverse mix of wetland and riparian plant species indigenous to the local area.

Standards of Success:

After five years (2004)

a. 50% aerial cover of woody species in the scrub-shrub and forested zones of the site.

b. At least 80% aerial cover of vegetation in the emergent zone, of which 60% of the species are native.

Contingency Plans

Mitigation goals will be accomplished with native plantings. Contingency plans will include replanting the site in case of planting failure or other unforeseen problems. Determinations of success of plantings and overall vegetation of the site will be guided by standards of success as stated.

In the event that aerial coverage of wetland forest, scrub-shrub, or emergent vegetation falls short of the listed performance standards, (i.e., year 5) the site will be replanted to bring it up to levels stated. The DOT environmental staff will coordinate with appropriate agencies to agree on remedial action.

Appendix C

SR 823 Selah Success Standards

The following excerpted is from the *SR 82 Selah – Yakima Interconnect Final Wetland Mitigation Plan* (Watson and Russell 1995). The standards addressed this year are identified in **bold** font.

Mitigation Goals

The goals of wetland mitigation are to replace the lost functions and values of the impacted wetlands. WSDOT proposes to create 1.30 hectares (3.2 acres) of mixed palustrine forested/ scrub-shrub/ emergent wetland and 0.33 ha (0.80 acres) of buffer. In addition a buffer area of 0.17 ha (0.41 acres) would be preserved. It is intended that creation of the wetland will produce an ecologically diverse system providing wildlife habitat & food chain support, ground water discharge, flood attenuation in very large flood events, sediment/ toxicant retention and nutrient removal & transformation. These functions will enhance the riparian ecosystem of the Yakima River corridor.

Because this site has the potential for some contact by park users, an interpretive sign is being developed for prominent placement in the mitigated area. This sign will contain basic wetland ecology information and a request to leave the wetland area undisturbed.

Objectives and Standards of Success

Objective: Create a wetland community vegetated with a diverse mix of wetland and riparian plant species similar to those natural to the area.

Standards of Success: ***after five years***

a. The site will have attained greater than or equal to 50% cover by at least 3 woody species in the forested and scrub-shrub zones of the wetland.

b. ~~**The emergent zone will have an overall vegetative cover of greater than or equal to 85%; cover of non-native species will not exceed 10%.**~~[13]

Contingency Plans

Mitigation goals will be accomplished with successful native vegetation plantings. Contingency plans will include replanting the site in case of planting failure or other unforeseen problems.

[13] Site management has altered the portion of the site that was initially intended as emergent. An official revision has been made making this standard obsolete.

In the event that aerial coverage of wetland forest, scrub-shrub or emergent vegetation falls short of the listed performance standards, additional measures will be employed to assure the establishment of a viable wetland plant community at the site. These measures include regrading the site in the event that the hydrology is too deep or otherwise insufficient for plant success.

Construction and Planting

Vegetation to remain on the site as an island will be protected during site construction with temporary fencing placed at the edge of the drip lines. Detailed instructions for evacuation, placement of soil amendment, plant materials and plant spacing are provided in Appendix F. As-built plans will be provided to the WSDOT Environmental Office responsible for plan development and monitoring. The mitigation site will be fenced on all sides to discourage disturbance by park users or other people.

Monitoring

The wetland mitigation site will be monitored by a WSDOT biologist at the following times: after grading, (before planting); after planting; and approximately one year after planting. The first two visits will focus on verification that the site is being developed as specified in the mitigation plans. If errors are found, remediation will be required before additional work may be completed. The third visit, approximately one year after final planting, will include description and rough mapping of plant communities, observations of wildlife and hydrology, and documentation with color photos. If it is determined at that time that the wetland is in need of remedial work, specific suggestions will be noted for follow-up action by WSDOT.

Glossary of Terms

Abundance (total) – the total number of individuals, cover, frequency of occurrence, volume, or biomass of a species, or group of species, within a given area.

Accuracy – the closeness of a measured or computed value to its true value.

Adaptive management – the process of linking ecological management within a learning framework (Elzinga et al. 1998).

Aerial cover – is the percent of ground surface covered by vegetation of a particular species (or suite of species) when viewed from above (Elzinga et al. 1998). Values for aerial cover are typically obtained from point-line, point-frame, or line-intercept data.

Areal estimates – are made using the known boundary of a feature or statistical population. Areal estimates are often expressed in units of area.

Aquatic vegetation – includes submerged and rooted (*Elodea*, *Myriophyllum*) or floating (non-rooted) plants (*Lemna, Azolla, Wolfia*). For compliance purposes, these plants are not included in cover estimates. Vascular, rooted, floating-leaved plants *are* included in cover estimates (e.g., *Nuphar, Potamogeton*).

Bare ground – an area that can support, but does not presently support vascular vegetation.

Canopy cover – the coverage of foliage canopy (herbaceous or woody species) per unit ground area.

Community – a group of populations of species living together in a given place and time.

Confidence interval (CI) – is an estimate of precision around a sample mean. A confidence interval includes confidence level and confidence interval half-width.

Cryptogam – any of the *Cryptogamia*, an old primary division of plants comprising those without true flowers and seeds including ferns, mosses, and thallophytes (algae, fungi, and lichen).

Density – the number of plants per unit area (typically square meters).

Densitometer – a hollow T-shaped polyvinyl chloride (PVC) device that includes horizontal and vertical leveling and a mirror to locate a precise vertical point in space either directly above or directly below the densitometer. Target vegetation intersecting the vertical line of sight through the instrument is recorded.

Herbaceous – with characteristics of an herb; an annual, biennial, or perennial plant that is leaflike in color or texture, and not woody.

Hydric soils – soils formed under the conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (Federal Register 1994).

Invasive – a plant that interferes with management objectives on a specific site at a specific point in time (Whitson 2001). For monitoring purposes, invasive species include those listed on the current County Noxious Weed List, and on a site-by-site basis, other species may be included (such as *Rubus armeniacus* (Himalayan blackberry)).

Line-segment – a linear sample unit that is used to measure vegetative cover.

Macroplot – usually refers to a relatively large sampling area in which sub-sampling will be conducted, often using quadrats, line-segments or point-lines (Elzinga et al. 1998).

Open water – an area intended to be non-vegetated and permanently inundated as described in the site mitigation or planting plan.

Point-frame – is a square or rectangular quadrat that consists of a set of identified points used to collect vegetation data.

Point-intercept device – a tripod that supports a rod that can be leveled and lowered vertically to intercept target vegetation at an identified point.

Point-line – linear series of points comprising a sample unit.

Point quadrat (points) – a single point, used to sample vegetation data. The point quadrat is theoretically dimensionless.

Population (biological) – all individuals of one or more species within a specific area at a particular time.

Population (statistical) – the complete set of individual objects (sampling units) about which inferences are made.

Precision – the closeness of repeated measurements of the same value.

Quadrat – an area delimited for sampling flora or fauna; the sampling frame itself.

Random sampling – sampling units drawn randomly from the population of interest.

Relative cover – the relative cover of a plant species (or suite of species) is the proportion of the target species coverage compared to that of all species in the plant community combined (Brower et al. 1998).

Restricted random sampling method – a sampling method that divides the population of interest into equal-sized segments. In each segment, a single sampling unit is randomly positioned. Sampling units are then analyzed as if they were part of a simple random sample (Elzinga et al. 1998).

Sample – a subset of the total possible number of sampling units in a statistical population.

Sample size equations – use sample mean and standard deviation to determine if data have been collected from enough sample units to meet the sampling objectives.

Sample standard deviation – a value indicating how similar each individual observation is to the sample mean.

Sampling – the act or process of selecting a part of something with the intent of showing the quality, style, or nature of the whole.

Sampling objective – a clearly articulated goal for the measurement of an ecological condition or change value (Elzinga et al. 1998). Sampling objectives provide a complement to success standards and describe the desired level of precision for sampling. Elements of a sampling objective include the desired confidence level and confidence interval half-width, or the acceptable false-change error and acceptable missed-change error level.

Sampling units – the individual objects that collectively make up a statistical population.

Standard deviation – a measure of how similar each individual observation is to the overall mean value.

Shrub – a woody plant which at maturity is usually less than six meters (20 feet) tall and generally exhibits several erect, spreading, or prostrate stems and has a bushy appearance (Cowardin et al. 1979). The species categories in this report follow Cooke (1997).

Species richness – the total number of species observed on a site.

Structures – any structure that is not expected to support vegetation during the monitoring period. Structures may include habitat structures, rocks, and other artifacts.

Stratified random sampling method – the population of interest is divided into two or more groups (strata) prior to sampling. Within each stratum the sample units are the same. Sample units from different strata may or may not be identical. Random samples are obtained within each group (Elzinga et al. 1998).

Systematic random sampling method – the regular placement of quadrats, points, or lines along a sampling transect following a random start.

Transect – for vegetation surveys, the transect is a line used to assist in the location sample units (point-lines, quadrats, line-segments or frames) across the monitoring study area.

Tree – a woody plant that at maturity is usually six meters (20 feet) or more in height and generally has a single trunk, unbranched for one meter or more above ground, and more or less definite crown (Cowardin et al. 1979). The species categories in this report follow Cooke (1997).

Vegetation structure – the physical or structural description of the plant community (e.g. the relative biomass in canopy layers), generally independent of particular species composition.

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